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THE FOURTH INTERNATIONAL GRASSLAND CONFERENCE.

To the average layman, a conference on grassland or grassland management sounds superfluous. Grass, in his eyes, is just what grows on land left to itself, though he sometimes realises that it forms an important part of the ration of ordinary farm animals. It must be admitted that many farmers, or one should perhaps say many of those engaged in agriculture, are little further advanced than this, in their appreciation of the astonishing power which man possesses in the management of grassland to improve its quantity, its quality and its availability.

In order to further the study of such questions, an International Grassland Congress Association has been formed, and this body held its fourth Congress in Great Britain during the past summer. The paper reading sessions held at Aberystwyth on July 14th to 18th, were preceded by a five days tour which was immensely interesting for the opportunity it gave delegates of appreciating modern developments in English grassland farming. The tour took the Congress to typical grassland farms in Leicestershire, Warwickshire and the Cotswolds, and left a profound impression of the many alternatives open to the farmer, even in such an apparently simple matter as the treatment of grassland. The British farmer is despised sometimes for his conservatism, though in refusing to adopt new and untried modifications of established practices he is probably right, but at the same time, there always seem to be a few farmers who are ready to break away from tradition and to modify their methods to suit new conditions.

An admirable illustration of this adaptability was shown in visits paid on the same day to two dairy farms, both of which were working on new and rather unorthodox lines. In one, managed by a retired business man, the cows were treated as nearly as possible as machines, and lived what appeared to be a very artificial existence. The whole organisation of the dairy was most efficient and business-like and the same may be said of the arrangements for marketing the milk. As a business, it was successful, in that it showed a handsome profit, the only doubt in the visitors' minds being whether the cows would continue to thrive and bear healthy stock in such conditions. At the other dairy, situated well up on the Cotswolds, the cows lived out-of-doors the

year round, and were milked in the field, in a portable " Hosier " bail which was moved across the pastures at regular intervals. This was a complete unit containing milking machinery and arrangements for sterilising the apparatus and utensils. There was no doubt that the animals looked far better under this system, whatever other disadvantages there might be.

To the visitor from the tropics, many of the points noted were naturally of slight interest. A delegate from Trinidad is not interested, for instance, in a technique of pasture control which will ensure production at special seasons, for with the well-distributed rainfall of this Island, plant growth is hardly checked throughout the year. Of more direct interest were the experiments carried out at the Welsh Plant Breeding Station, at Aberystwyth, which demonstrated how comparatively small changes in periods of grazing and periods of rest affect the proportion of the different components in a grassfield and ultimately, completely change the nature of the sward. Such experiments offer great hope that much greater value can be obtained from some of our tropical grazing areas—it will be years before we can call them pastures—by the introduction of a system of management, which will include what many of them seldom get under present conditions, periods of rest.

Professor Stapledon, as President of the Congress, was the leading spirit of the paper-reading session at Aberystwyth, and did not mince his words when giving us his views on the condition and the management of grassland in Great Britain. He holds strongly the view that permanent grass, which it is possible and at all reasonable to plough, is wrong in theory and uneconomic in practice. This is indeed the swing of the pendulum, and it cannot yet be said that Professor Stapledon's theories command general assent. It is of course true that the new strains of grasses and clovers that are being produced by his school at Aberystwyth, have altered the question considerably in the last decade, but it will be sometime, one imagines, before he persuades the grassland farmers of Market Harborough—to quote one example—to plough up their rich permanent pastures, which, at present, fatten more than a bullock to the acre.

A most carefully worked-out demonstration programme enabled every delegate to obtain a comprehensive idea of the work of the Welsh Plant Breeding Station, and for this nothing but praise can be given. The demonstration was backed up by an excellent exhibit staged in the main conference building which displayed turves showing every conceivable grassland type, and the improvements which can be brought about by suitable management, manuring and cultivation. There was also a large exhibit demonstrating the genetics of red clover and grass breeding, including some pots of a diminutive red clover of the DWI type, which is recessive to the normal. The influence of the grazing animal on pasture and the persistency of indigenous strains as opposed to commercial types was also demonstrated by typical turves. The commercial production of these new strains is of special interest to agricultural workers in the tropics, who are accustomed to regard the multiplication and distribution of new strains of seed as part of their normal job. Such work in England, would naturally be taken over by the seed trade, but little is known about grass and clover seed production and the technique is being worked out by the Plant Breeding Station, which is arranging with farmers in different districts to undertake this work on a commercial scale. The delegates visited some of these seed-growing farms, and it is satisfactory to note that steps have been taken to form a new association of seed-houses and seed-growers, to work with the guidance and help of the Welsh Plant Breeding Station, in handling the extensive trade that is expected in these new pedigree grass and clover strains.

It is not possible, in a short article, to deal, even summarily, with the numerous papers that were read at the Congress. The most interesting that the present writer heard was from W. R. Chapline, the Chief of the Division of Range Research in the United States Forest Service, on the work of his Department. The speaker described and classified the research being done, under four broad phases, range forage, range management, artificial revegetation and watershed protection, all of first importance in view of the recently aroused realisation of the dangers of erosion in tropical lands.

The Congress was attended by some 450 delegates from thirty-seven countries and not the least of its benefits was the opportunity it afforded of meeting other workers in tropical agriculture. Delegates received the greatest hospitality from all concerned and the transport and general arrangements deserve a special word of commendation.

R. C. W.

The Late Professor H. A. BALLOU.

It is with profound regret that we have to announce the death on Wednesday, 3rd November, at Bridgetown, Barbados, of Professor Ballou, who retired at the end of 1933 from the posts of Professor of Entomology and Commissioner of Agriculture for the West Indies, at the Imperial College of Tropical Agriculture. An account of Professor Ballou's career, which was written in appreciation of his signal services not only to the College but also to the West Indies was published in the 1933 December issue of this Journal. All past and present members of the College deeply sympathise with Mrs. Ballou in her irreparable loss.

SPECIFIC AND VARIETAL SUSCEPTIBILITY OF BANANAS TO CERCOSPORA LEAF SPOT.

By E. E. Cheesman and C. W. Wardlaw.

In Fiji and Australia, all commercial varieties of banana, including the Gros Michel, Cavendish, tall sports of the Cavendish, Lady's Finger (?) and Sugar varieties, are reported in the earlier literature as being susceptible to Cercospora (*C. musae* Zimm.) leaf spot. In Queensland the Red Dacca appears to possess definite resistance. In Fiji, according to a recent report, the Lady's Finger, Mysore, Blue Java, Vudi loaloa, Soaqa (*Musa fehi*), 'Jamaica' and Jamaica vula have so far shown immunity; Bawa, Baloa, Sauvai and Jamani bula show resistance; of the commercial varieties, one strain of Gros Michel (Domoloa) and one of Cavendish give indication of possessing some resistance.

Since the first recognition of the disease in 1933-34 in the Caribbean region and in the Guianas, various commercial varieties, including the Gros Michel, Dwarf Cavendish, Congo and Giant Governor have proved highly susceptible to this disease under plantation conditions. When plants of the Imperial College Hybrid, I.C.2 (derived from *M. acuminata*, a wild seeded species as male parent, and the Gros Michel, as female parent) were established in close proximity to Gros Michel plants on which the disease had appeared with great severity, it was observed that the rate of appearance of spots was slow and that the total extent of the infection was relatively unimportant. This hybrid variety, in brief, apparently possesses considerable inherent resistance to infection or exploitation by *Cercospora musae*. In view of the very considerable commercial losses which the Cercospora leaf disease is now causing in the Caribbean region, the foregoing observation again directs attention to the importance of attempting to secure new commercial types of banana by appropriate hybridisation studies.

By way of amplifying our knowledge of the relation between hereditary constitution and susceptibility to this disease, a survey has been made of the very considerable collection of types, species and hybrids available for study at the Imperial College of Tropical Agriculture. Data for the type collection are set out in Table I.

In each of the three locations, the type collection forms a closely grouped assemblage of plants; the same general liability to infection by *Cercospora musae* is therefore present throughout. With regard to the parasitism of *C. musae*, three quite definite conditions have been recognised: of the 22 types and 2 sub-types, 13 are definitely susceptible, 8 are highly resistant or immune, and 3 (Mysore, Orotava and Male) are *mildly* susceptible, spotting as a rule occurring only on the oldest leaf of fully grown plants, or plants bearing bunches.

Among the species collection, a high degree of resistance is the rule. *M. acuminata* Colla (clone A), *M. balbisiana* Colla (clone Ceylon), *M. textilis* Nee, *M. ornata* Roxb., Pisang Lilan, and undetermined species from Annam and Burma are quite free from Cercospora spotting, though in close proximity a Gros Michel stool shows characteristic spotting. On *M. violascens* Ridl. and undetermined species from New Guinea (?*M. Banksii* F. v. M.) and Samoa, occasional spots are present, but in each instance they are restricted to the oldest senile leaves. In another collection, of five varieties of *M. acuminata*, all are free from spots except clone E, on which some typical spots are present in the oldest leaf. Among a third collection comprising 16 different clones referred to *M. balbisiana* (*M. sapientum* L. *sensu* Roxb.) no spotting has occurred.

In the collection of Imperial College hybrids, numbered 1-39, most of the plants are quite free from leaf spotting, I.C. 6, 7, 9 and 24 (oldest leaves only) being interesting exceptions; the first three of these are F_2 seedlings from the resistant I.C.1. Among a large number of other hybrids in which hereditary characters

Table I.

Type Number.	Name.	Location. Field 1.	Field 2A*	Field 2B†
1	Gros Michel ...	+	+	+
2	Dwarf Chinese ...	+	+	+
3	Giant Chinese ...	+	+	+
4	Congo	+	+	+
5	Tall Cavendish ...	+	+	+
6	Mysore	-	+M	+M
7	Red ...	+M	+	+
7A	Green Red ...	+	+	+
8	Orotava ...	+M	-	+M
9	Male	-	+M	+M
10	Rio	+	+	+
11	Bluggoe	-	-	-
11A	Silver Bluggoe ...	+	-	-
12	Awak Legor ...	-	-	-
13	Unnamed var. ...	-	-	-
14	Unnamed var. ...	-	-	-
15	Pome	+	+	+
16	Marathuva ...	+	+	+
17	Silk ...	+	+	+
18	Rajah	-	-	-
19	Sucrier	+	+	+
20	Unnamed var. ...	-	-	-
21	Palembang ...	-	-	-
22	Bande	+	+	+

* 2 years old. + susceptible. M. Mild infection.
† 1 year old. - resistant

from parental wild species are prominent, a noticeable absence of leaf spotting is the rule. These hybrids have been raised in the course of a breeding programme directed primarily towards the control of Panama Disease and their resistance to an entirely different malady is as interesting as it is potentially important.

In both the species and hybrid collections it is to be noted that infections described as mild are all characteristically of one kind, spotting occurring only on the oldest leaf. Recent field observation on plots of I.C.2, located in different parts of the island, indicate that where *Cercospora* infections occur, they are invariably of the mild type. In leaves brought in for examination as being badly infected, the preponderance of spotting has been due, not to *Cercospora musae* but to *Cordana musae*, a weak parasite on senile leaves.

Reverting to Table I, it may be of interest to point out that the 8 varieties highly resistant to *Cercospora* are all likewise highly resistant to Panama Disease. The resistance is in neither case of much direct economic significance, because the varieties concerned are of no use as export bananas themselves, and probably equally useless as parents of new export types. Five of them (Nos. 11, 11A, 12, 13 and 14) are rather coarse cooking bananas belonging to a group quite distinct from the dessert types. Nos. 20 and 21 are sterile diploids from which it seems impossible to raise seedlings of any commercial value at all, and only Type 18 (Pisang Rajah of Malaya) shows any characters of promise. Two of the three mildly susceptible types, No. 6 (Mysore) and No. 8 (Orotava) are immune to Panama Disease, give progeny freely, and have been regarded as of sufficient promise to warrant further trial as parent stocks, though only of indirect usefulness.

The numerous other qualities required of a commercial banana remain the same whether it is to be bred resistant to a wilt or to a leaf spot, and evidence has accumulated to show that combining those qualities in a single plant is the real problem of banana breeding, rather than disease resistance alone. The conclusion has already been drawn that the greatest hope of obtaining a good export banana resistant to Panama Disease lies in breeding from Gros Michel with appropriate wild species. It therefore follows that the best hope of obtaining a good export banana resistant to Cercospora leaf spot lies in the same direction.

From this point of view it is the resistance of the wild species in the Imperial College collection, and of the I.C. series of seedlings raised by their use, that is of the greatest economic significance. New varieties like I.C.2, which represent the best results of banana breeding to date, are still inferior in some respects to Gros Michel, but there is little doubt that they can be improved upon as the range of available breeding material widens, and they already serve to show the potentialities of a line of work which is perhaps only at its beginning.

SUGAR-CANE BAMBOO HYBRIDS.

Remarkable results have been obtained by Rao Bahadur T. S. Venkatraman, in his work on the intergeneric hybridization between sugar-cane and bamboo—*Bambusa arundinacea* (*Ind. Jour. Agri. Sci.*, 1937, 7, 513). "Success in sugar-cane breeding depends largely on the extent of variation which it is possible to induce in the seedlings raised; and it was felt that the bringing in of other *genera* (other than *Sorghum Durra* Stapf.) might increase the range of such variation and perhaps also open out new lines of advance." The first attempt to effect a cross betwen sugar-cane and bamboo which on a previous occasion was given up, was renewed in December, 1936.

"On the sugar-cane side the parents employed were two Java canes, POJ 213 and POJ 2725: these were the only varieties available for crossing at the time, December being practically the end of the cane flowering season at Coimbatore. Both these canes have little fertile pollen of their own but set seed profusely when cross-pollinated with other cane varieties. POJ 2725 was the cane which was first used in the intergeneric hybridization with sorghum. The bamboo pollen employed was that of *Bambusa arundinacea* Willd. from Madras, the few available inflorescences being railed to Coimbatore in special receptacles. The attempt has yielded twenty-nine hybrids—eighteen with POJ 213 and eleven with POJ 2725 as mother parent."

"Though even from the very early stages these hybrids displayed characters not previously noticed in sugar-cane seedlings during almost a quarter century of sugar-cane hybridization at Coimbatore, this announcement was delayed till the plants showed definite and clear bamboo characters. These have since been found in the mode of underground branching, nature of shoot and bud formation, central cavity in the stem, anatomical characters of the stem and root and number of chromosomes."

"It is well known that sugar-cane seedlings display considerable variations among themselves in the F_1 generation. The present batch of twenty-nine hybrids show similar variations and different bamboo characters are showing themselves in different plants. They further show abnormalities even more numerous than those met with in the intergeneric cross with sorghum."—(*Current Science*, Vol. VI, No. 2, p. 75, 1937.)

FORAGE PRODUCTION IN TRINIDAD.

By

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Agricultural progress in the tropics is intimately linked up with the question of livestock improvement. This fact has been widely recognised by Colonial Agricultural Administrators, and in most tropical colonies, livestock selection and breeding have been going on for a number of years. In consequence, the distribution of quality animals for crossing with and grading up the indigenous stock is almost world-wide. It is unfortunate that this branch of agricultural research has advanced considerably ahead of the cognate investigations on grazing technique and forage crop production (1, 2). Actually, the rations on which tropical livestock is expected to survive and fulfil all its various functions are usually very inadequate, especially at certain low-productive seasons of the year. It is generally admitted that the class of animal a country possesses depends on the class of feeding which is provided (3). It follows that one of the limiting factors in stock improvement is the quality of the rations, and it has been amply demonstrated that, under inferior conditions of maintenance and management, high grade animals either die off or rapidly degenerate towards the level of the indigenous scrub animal. Realisation of these facts has brought problems of pasture and fodder crop management into considerable prominence and a brief discussion of the existing practices in Trinidad and of possible methods of improvement should therefore be of some interest. Since cattle are the most important type of livestock in the island (4), it is proposed, for the sake of simplicity, to limit discussion to forage problems as they affect this class of animal.

The type of ration fed to cattle in Trinidad depends on the system of management, which may be either extensive or semi-intensive in character. The majority of the stock owned by local cultivators are reared on the extensive system, while the large herds of animals belonging to sugar estates and commercial dairies may more correctly be relegated to the latter. The small-holder, who is generally of East Indian extraction, feeds his oxen on inferior crop residues, such as rice straw or cane trash, and on the natural herbage growing by the roadside, on waste lands, and under cultivated plantations of coconuts, citrus, &c. The animals may be tethered in any suitable place and allowed to graze, or the herbage may be cut by hand and fed in the green condition on the soiling system. In either case, the nutritive quality of the ration is very low, as the coarser grasses and annual weeds flourish at the expense of the more desirable pasture species. Selective grazing and mowing assist in the concentration of the less palatable herbage. The bulk of the ration is often inadequate, as the animals are used indiscriminately for work, meat or milk, and the time allowed for grazing or soiling is frequently insufficient to yield the necessary quantity. The use of concentrates, with the possible exception of small quantities of molasses, is practically unknown. The accommodation available for the animals is of the poorest.

On the second system, a very different state of affairs prevails. Byres or cattle-pens of fairly modern design are provided, and the stock spends a considerable proportion of its life in confinement. This is partly because the cattle are kept as a source of farmyard manure and also because the land enclosed for grazing is often very limited in extent. In the case of dairy herds, stall feeding offers the added advantage of convenience in milking. The roughage supplied to the animals varies with the season of the year. During the sugar-cane harvest in the dry season, it consists almost entirely of cane tops. These are of fair nutritive quality and are available in practically unlimited amount, so that the cattle usually thrive at this period. In the wet season, from July to January, the roughage comprises mixed herbage cut from the cane field traces or from any other available uncropped land, along with a proportion of green fodder obtained from cultivated perennial grass crops. The proportion of cultivated to natural herbage depends on the particular estate: on the sugar plantations, the area put down to cultivated fodder crops is relatively small, and is used as a reserve supply during the less productive months of the year. In the feeding of most of the dairy herds, the majority of the roughage is cut from cultivated forage crops. In addition to the roughage, the stock is usually given an appreciable quantity of a concentrate mixture, of which molasses is the commonest ingredient. Apart from its nutritive value, the molasses has the added advantage of improving the palatability of the bulk ration and increasing the appetite of the animal. The working oxen get little other concentrate food, but the milch cows and breeding stock, in proportion to their requirements, are given adequate quantities of a balanced concentrate mixture. By selective breeding and the use of pedigree bulls, the general standard of most of the herds is improving. In the circumstances in which it is reared, this grade stock survives and thrives satisfactorily.

Under both these systems of management, there appear to be various ways in which the quality of the roughage could be improved on an economic basis. In order to clarify discussion, it

is proposed to adopt the following classification so as to effect a more detailed analysis of the available types of forage :—

Grazing	Rough.
	Natural Pastures.
	Cultivated Pastures.
Cultivated Fodder Crops	Annuals.
	Perennials.

Rough Grazings.

The botanical composition of the herbage from the rough grazings, as used by local stockmen, is very mixed in character, and varies with the kind of soil, the degree of shade, the presence or absence of plantation or other crops, drainage, &c. As already mentioned, coarse, tufted, low-quality types of grass predominate, though no dense sward in the proper sense of the term occurs. A fair number of annual weeds or shrubs may be present, and these also are generally of low nutritive quality, and certain species may even be poisonous to stock. The bulk of material varies from comparatively little on overstocked communal grazings to a fair yield of inferior roughage from waste lands on which most of the grasses have been allowed to grow to an overmature stage of development. The commoner species include :—

Bahama Grass—*Cynodon dactylon* (L.) Pers.
Para Grass—*Panicum barbinode* Trin.
Savannah Grass — *Axonopus compressus* Beauv.
Bamboo Grass or Brown Millet—*Panicum fasciculatum* Swartz.
Corn Grass—*Manisuris exaltata* Kuntze.
Fowl-foot Grass — *Eleusine indica* (L.) Gaertn.
Gamalote—*Chaetochloa sulcata* Hitchc.
Nut Grass—*Cyperus rotundus.*
Sour Grass—*Paspalum conjugatum* Bergius.
Tapia Grass—*Sporobolus indicus* (L.) R. Br.
Baji or Wild Spinach—*Amarantus spinosus.*
Rabbit's Meat—*Alternanthera ficoidea*; also *A. sessilis.*
Sensitive Plant—*Mimosa pudica.*
Commelina—*Commelina elegans.*

With the possible exception of the first two they are all considered to be of low nutritive status, and to contain a high percentage of fibre, especially at the rather mature stage at which they are generally consumed. When such herbage comes from waste and common land, there seems little chance of effecting any marked improvement. On small holdings or on estates under competent management, it should be possible to raise the standard of the roughage by introducing a more scientific system of management which would tend to encourage the better species and discourage the coarse types. Under the soilage system, the correct stage of development of the herbage, so as to obtain the greatest nutritive value per acre, would first have to be determined, and a regular mowing rotation should then be inaugurated. It is thought that more frequent cuttings, than are at present taken, would be advisable. This would mean that the grass would be utilised at a younger and more nutritious stage of growth. The level at which the herbage is cut should be uniform and low enough to encourage the spread of bottom grasses which often include the more desirable species. In the productive seasons of the year when there is liable to be excess herbage, the surplus produce could most profitably be turned into silage, or alternatively used to increase the tonnage of farmyard manure. When the area is being grazed, the best grazing rotation would have to be determined, and by tethering or by temporary paddocks, every effort should be made to ensure that each section in turn is grazed closely and uniformly at the correct intervals. If at any time, the head of stock is insufficient to keep the herbage down, there will be a tendency for the animals to pick out the good species and leave the coarse. It would then become necessary to complete the work of the stock with a scythe or cutlass and mow the ungrazed herbage (5). Where practicable, manuring, draining, sowing seed or other method of establishing better species should be employed in order to effect a rapid improvement of the pasturage. It is not possible at present to give more explicit details of the correct technique to adopt, as scientific information on this subject is very meagre. Some of the better species of grass are enumerated in the section on cultivated crops.

Pastures.

By pastures is implied areas covered by a more or less dense perennial sward, akin in character to a rather coarse lawn, and kept down by close grazing or other means. Savannah or Carpet Grass (*Axonopus compressus*) is the only pasture grass of any agricultural significance that is grown in Trinidad today. It flourishes during the wet season and survives well enough during the few dry months at the beginning of each year. It is only of average to low nutritive quality (6, 7). In humid conditions and particularly on soils of rather low fertility, it is hardy and aggressive, and under a controlled grazing system, it can maintain a good thick productive sward for many years. If it is cut too closely or too frequently as in garden lawns, it is likely to become patchy in time, and other grasses or weeds such as Nut Grass, Bahama Grass, Fowl-foot Grass, Tapia Grass, Drymaria, species of Desmodium or Sida establish themselves.

There is considerable room for improvement in the management of the Savannah Grass pastures in Trinidad. Some preliminary research work would be advisable to give effective direction to any proposed measures. The grazing rotation likely to yield the maximum tonnage compatible with good quality and persistence would have to be determined. At reasonable intervals, a rest period, when the sward is given temporary relief from continuous close cropping, would almost certainly be beneficial (8). There are various

distinct strains of Savannah Grass, and botanical selection of the indigenous material might segregate a much improved type. The possibility of introducing a legume into the sward should be investigated. The discovery of a suitable legume which would thrive in association with Savannah Grass would do a great deal to compensate for the rather poor quality of the grass. In other tropical colonies, certain species of Desmodium, Lespedeza, Alysycarpus, and Meibomia have been tried with some success (9-12).

Cultivated Pastures.

Recent progress in grassland research in the tropics indicates that it should be possible, at least on the more fertile soil types, to introduce a more nutritious pasture species than Savannah Grass. This would entail the artificial establishment of the new species by ordinary cultural methods, ploughing, harrowing, sowing, &c. On a large scale, the question of expense would limit the choice to species that can be propagated fairly easily from seed, and the maintenance of the improved pasture would need more skilful management, and possibly manuring, to allow the exotic species to compete successfully with the indigenous. The following grasses, on account of their favourable growth habits, quality and climatic requirements, suggest themselves as worthy of a trial on a small scale :—

Dallis Grass—*Paspalum dilatatum* Poir. (6, 14).

Finger Grass—*Digitaria decumbens* (15).

Rhodes Grass—*Chloris gayana* Kunth. (5, 9, 14, 15).

Sheep Grass—*Brachiaria dictyoneura* (13) *Brachiaria decumbens.*

Star Grass—*Cynodon plectostachyum* Pilg. (8, 16).

Several distinct varieties of most of these species have been isolated in other countries, and the best strain for growing under the conditions of soil and climate obtaining in Trinidad should be determined by trial.

Cultivated Fodder Crops.

The greatest potentiality for immediate improvement in stock rations lies in the better development of cultivated fodder crops. Their use would imply a more intensive system of livestock management than is at present practised by native cultivators. In Trinidad, the growing of a cultivated fodder crop is generally associated with the soiling method of rationing livestock, green herbage being cut and fed daily. A proportion of the crop might easily be turned into silage or artificially dried and stored for use in the dry season. In the humid tropics, the annual yield of green fodder of fair quality may vary from 30 to over 100 tons per acre depending on the soil type and the particular fodder grass grown (17-19). When consumed at the rate of 80 to 100 lb. of roughage per head per day, this yield is sufficient to maintain, in good condition, from two to seven head of cattle per acre. In order to maintain the yields at this high level, it will almost certainly be necessary to conserve the fertility of the soil by regular manuring. The farmyard manure might be utilised for this purpose, or, if the organic manure is required for other more valuable crops, a suitable mixture of artificial fertilisers would serve.

Annuals.

These may be regarded as the tropical equivalent of the hay crops of temperate regions. They are quick growing species, established from seed sown thickly either broadcast or in rows, and utilised while they are still in the vegetative stage of development. They may occupy the ground for three to nine months or more, and from one to six crops (34) may be taken before the land needs to be reploughed. When cut at the proper stage, the quality is fair and the yields are good though not up to the level obtainable from a well-established perennial grass. Among the annuals, may be included the residues from arable crops, which form an important source of forage for the stock. To this class belong sweet potato vines, maize stover, rice straw, and the roughage from all types of pulse crops. The quality is very variable, from fairly nutritious as in the case of leguminous crop residues, to very poor, for example, maize stover or rice straw. An excellent annual fodder crop is a mixture of a cereal and a legume as exemplified by the English Dredge-Corn, a combination of oats and tares. In a good mixture of this kind, the two species should be mutually beneficial, and the resultant yields should be better both in total bulk and quality than could be obtained from either separately. The following species are suggested as possible annual fodder crops for Trinidad, but their relative merits and correct utilisation have not yet been accurately determined.

Great Millet—*Sorghum vulgare**.

Job's Tears—*Coix Lachryma-Jobi*, L.

Maize—*Zea mays*, L.

Teosinte—*Euchlaena mexicana* Schrad. (20, 21) *Andropogon gayanus* var. *signamulatus* Stapf. (35).

Sudan Grass—*Sorghum sudanense* Stapf.

Alysicarpus—*Alysicarpus rugosus* (13, 24).

Bengal Beans—*Stizolobium aterrimum.*

Cowpea—*Vigna unguiculata* (L.) Walp.

Indigofera—*Indigofera tettensis* (23).

Japanese Clover—*Lespedeza striata* (13, 24).

Soya Bean—*Glycine max.* (L.) Nerr.

Sword Bean—*Canavalia ensiformis.*

Townsville Lucerne—*Stylosanthes sundaica* (13, 24).

Woolly Pyrol—*Phaseolus mungo.*

Sunflower—*Helianthus annuus.*

* In certain climatic zones, the danger of cyanogenetic poisoning of livestock fed on young sorghum forage should be noted.

PERENNIALS.

The most popular perennial fodder grass grown in Trinidad today is Uba Cane (*Saccharum sinense* var. *Uba*). This belongs to the thin cane group, is fairly hardy and gives good annual yields even on the relatively poor soils to which it is normally relegated for fodder production. It is cut at any phase of the vegetative development depending on the stock requirements and on the quantity of roughage available from estate traces and other sources. Alternative grasses that are sometimes used in preference to Uba cane are :—

Guatemala Grass—*Tripsacum laxum* Nash (2, 18, 25).

Elephant Grass—*Pennisetum purpureum* Schumach (4, 17, 18).

Coimbatore Cane—*Saccharum sinense* var. *Co.* 213.

Para Grass*—*Panicum barbinode* Trin. (25, 26, 27).

Guinea Grass—*Panicum maximum* Jacq. (14 15, 25, 26).

Recent experiments at the College indicate that certain of these grasses are definitely superior in yield and quality to Uba Cane (26). They also show that management on a more scientific basis, in place of the rather haphazard system on which these crops are at present utilised would be rewarded by considerable improvement in the quality of the roughage with little, if any, loss in quantity. Until further data concerning the management technique required for each grass are available, it is suggested that a cutting rotation of from two to three months should be used. If this rotation was employed, the height of the herbage obtained from most of the species enumerated would be from three to five feet at harvest. There is reason to believe also, that cutting at a rather higher level, up to one foot above ground, could be used with advantage. This high cutting would give a more leafy and therefore a more nutritious type of herbage. It also encourages quick sprouting of the ratoon crops, for the reason that the growing point of most of the tillers is not removed, and the time normally required to induce sprouting from dormant buds is therefore eliminated. On the other hand, continuous high cutting tends in time to produce a number of old or dead stumps on the stool which are rather prone to fungal attack. It is suggested that, at least once a year, the stools should be mown down to about ground level to remove the accumulated debris, and to encourage the growth of an entirely fresh series of tillers from the development of dormant buds at or below ground level.

An alternative method of utilisation is to employ a controlled system of rotational grazing. This might appeal to the small-holder with only a limited area which could be effectively worked by tethering the animals in a manner that would ensure uniform grazing of each portion of the field in turn. This alternative method is only practicable with species which will stand up to regular trampling by the animals and still retain their power of recovery for the production of the ratoon crops. This system has been successfully adopted with a cultivated crop of Elephant Grass in Hawaii (17). It should also be possible to graze Para Grass without detriment to the yield, but it is doubtful whether the other species mentioned are suited to a grazing technique.

Of the cultivated perennial crops mentioned, Guatemala Grass has given the best results to date yielding good bulk and a fair quality of forage with little cultural requirements after the initial establishment period. Para Grass is distinctly more nutritious but the total tonnage per annum is lower, and it would be advisable to limit its cultivation to damp, almost swampy localities, where it thrives particularly well (26, 27). Elephant Grass is slightly superior in quality to Guatemala Grass, and gives a much better yield under good conditions. In Trinidad, it has shown itself to be susceptible to fungal attack by a *Helminthosporium* sp., which at periodic intervals is liable to kill off a high percentage of the stools and reduce the yield to a negligible quantity (4). On account of its quality and productiveness, Elephant Grass is one of the most popular fodder grasses of the tropics, and an attempt is being made to isolate a resistant strain which could be safely recommended for cultivation in Trinidad.

It is necessary to emphasise that these recommendations are only provisional, being based on the results of experiments carried out on one soil type namely, the detrital sandy loam of the College Farm. They require verification and amplification by a further series of experiments on some other representative soils in the Colony, for which the relative merits of the different grasses, and the best method of utilisation may be markedly different.

Pasture research in other tropical and sub-tropical colonies indicates that there are many other species that might succeed as cultivated perennial fodder crops in Trinidad. Judging from their botanical and agricultural qualities, the best of these, if they thrive under local conditions, should be an improvement on any of the existing cultivated types. The following are suggested as likely alternatives :—

Kikuyu Grass—*Pennisetum clandestinum* Hochst. (6, 16, 23, 28).

Merker Grass—*Pennisetum purpureum* var. Schumach. (9, 17).

Molasses or Wynne Grass—*Melinis minutiflora* Beauv. (14, 27, 29).

Rhodes Grass—*Chloris gayana* Kunth (5, 8, 9, 14, 15).

Star Grass—*Cynodon plectostachyum* Pilg. (8, 16).

"Umfufu"—*Pennisetum purpureum* var. Schumach. (15).

Mexican Grass—*Ixophorus unisetus* Schlecht. (13, 33).

* Not generally cultivated.

Japanese Kudzu Vine—*Pueraria thunbergiana* (30, 31).
Kenya Clover—*Trifolium Johnstonii* (13, 32).
Stylosanthes *Stylosanthes guyannensis* (12, 13, 24).
Demerara Primrose—*Asystasia gangetica* (25).

This brief discussion of the forage problem, as it affects Trinidad, should suffice to show that by relatively minor modifications of existing practice, it might be possible to bring about a rapid improvement in the quality of the stock rations. Progress will be severely limited by the lack of accurate scientific information in respect to fodder crops and their utilisation. Research work on an extensive scale is urgently required in order to determine the relative merits of the known forage crops, both indigenous and exotic, and to ascertain the best method of utilising each one of them on different soils and under various systems of stock farming. The full significance of grassland research and its influence on agricultural policy and land preservation has been discussed elsewhere. In Trinidad, the problem is one of immediate importance so as to allow the stockfarmer here to keep abreast of the progress being achieved in other countries.

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SOUTH AFRICAN NATIVE CATTLE.

Little has been attempted by Europeans in the way of improving the cattle of Africa by selection within native breeds, the practice being to inter-grade with European breeds. H. H. Curzon and R. W. Thornton, realizing the potentialities of the native cattle, have laid a foundation for further investigations by outlining the cattle types of Africa and their approximate distribution (*Onderstepoort J. Vet. Sci. Anim. Ind.*, 7, 613; 1936). Probably all the breeds, except the Hamitic longhorn of Egypt, came originally from Asia, and all reached their destination through north-east Africa except the shorthorned zebu which was introduced along the east coast north of the Zambesi River. Three parent stocks are involved—Hamitic longhorn, brachyceros and lateral-horned zebu; and from these three other types have been derived—short-horned zebu, sanga, and lyre-horned zebu. In West Africa there are possibly two other types derived from admixture of brachyceros and Hamitic longhorn in one case, and in the other from brachyceros and thoracic humped zebu. The paper is illustrated by perhaps the most complete set of photographs of African cattle breeds yet published.—(*Nature*, Vol. CXL, No. 3543, p. 551, 1937.)

TROPICAL FRUITS AND VEGETABLES. AN ACCOUNT OF THEIR STORAGE AND TRANSPORT.

By. C. W. Wardlaw.
Low Temperature Research Station.

(Continued from *Tropical Agriculture*, XIV, 11, 1937.)

Tomato.—*Continued.*

Debuttoning.

In general, the trade requires that stem buttons and calyx shall be removed to prevent puncturing of the skins by the stem ends (48). In some varieties, in relation to the penetration of fungal pathogens, it has been found advantageous *not* to remove the buttons at harvesting (60). In such instances fruits should be clipped or broken off close to the button. It has been found that the development of infections at the stem end is largely dependent on the delay in placing fruit in cold storage and on the duration and temperature of storage. The proportion of button to other infections tends to be higher in fruits reaped without buttons (60).

Packing-Shed Treatment.

Fruits should be handled carefully at all stages from picking to packing. Attention to packing-shed sanitation and the immediate elimination of all diseased, cracked or bruised fruit are important in the reduction of wastage.

Disinfectant Treatment.—Ramsey and Bailey (42) have pointed out that tomato late blight rot, caused by *Phytophthora infestans*, a serious field disease of vines and fruits, may also be the cause of further wastage during storage and transport. They state that wastage may be greatly reduced by immersing fruits for two minutes in a disinfectant solution (one part formaline to 300 parts water), then allowing them to stand for four to five days before grading and packing. Expense, storage accommodation and other factors will preclude this treatment in many tomato-growing regions. The best control of this type of wastage is to be sought in the thorough treatment of the disease in the field (*i.e.*, by appropriate spraying or dusting).

Porte (40) has considered the advisability and effectiveness of subjecting fruits to chemical steeps as a means of controlling fungal wastage during storage and transport. Mature green fruits were submerged for three minutes in various washes, consisting of dilute solutions of formalin, borax, potash, soda and ammonium alums, bleaching powder, mercuric chloride and so on, maintained at 115° to 122°F. The fruits, some of which were inoculated with various fungi, were then held under conditions of temperature and humidity favourable to fungal development. In many instances, a notable reduction in the amount of wastage was observed; but where the fungus was already present in the form of latent or dormant infections (established in the field) washing treatments were not effective. Treatment with ethylene gas did not accelerate the development of fruit rots.

Florida tomatoes, according to a report written in 1920, are usually washed in a warm disinfectant solution for a short time, sprayed with clean cold water, then dried by being passed between two layers of sponges (50).

Standardisation of Packing Maturity.—Where large quantities of fruit of mixed maturity (*i.e.*, full-grown green, immature green, &c.) have been harvested together, as happens in some parts of Florida (50), the fruit is not packed immediately but is left for a few days in the packing house at 75° to 85°F. till most of the fruits show a slight development of colour. At this stage packing is begun; all diseased, bruised and undesirable fruits are discarded, green fruits being held over until they show colour. Where this procedure is in operation proper conditions of sanitation, ventilation, humidity and temperature must be maintained in the packing shed. Ripening operations such as those described above can only be practised during the cooler months. During the warmer months it is inadvisable to attempt the transport of coloured fruits, unless refrigeration is used. With fruit grown under moist tropical conditions, maturation as described above before transport is not advisable, on account of the rapid onset of fungal wastage at high temperatures (60).

Culling and Grading for Size.—On leaving the washing and drying apparatus, fruits pass over rollers where inspection and culling take place and are carried on to the mechanical sizer, by which the several grades of fruit are discharged down inclined planes into bins or pockets (29). With good equipment the fruits are not jarred or bruised in travelling from the washing tank to the packer. Sando (50) considers that machine handling is highly desirable. Grading by eye is practised in some regions. Various sizes have been standardised in different countries.

Grading for Colour.—When packing fruits already graded for size, grading for colour should also be given careful attention; this makes for an attractive uniformity in packs and minimises the wastage consequent on the juxtaposition of firm and softening fruits.

Wrapping and Packing.—Individual fruit wrappers should be used and crate liners adjusted before beginning packing operations. Good packing depends on accurate sizing. Firm packing of fruits, diagonally on their cheeks is considered desirable; slack packing, permitting of movement within the crate, makes for bruised fruit. In some regions it is considered an advantage to permit a little shrinkage to take place by leaving packed crates open for a few hours before nailing

down the lid ; *e.g.* where crates have been packed overnight the lids should not be nailed down until the following morning (24).

The wrapping of tomatoes in tissue paper for export is a well established practice. Some investigators, *e.g.* Sando (50), consider that wrapping interferes with ripening processes and makes for poor flavour and quality : subsequent experiments by Edmond (14) do not support this view.

Shill (54) regards the use of oiled wrappers and crate liners as being inadvisable : fruits in oiled wraps showed 25 per cent. more ripening than those in plain wrappers, suggesting, among other factors, a slower rate of cooling during refrigeration.

West Indian tomatoes for export are packed in the British Columbia 20 lb. lug, with inside measurements of 15¾ by 15¾ by 4½ inch. The standard tomato crate or lug used in Jamaica for shipment of fruit to Canada, the Mexican 30 lb. lug, measures (inside) 16¼ by 13½ by 5¾ inch (33). For Australian tomatoes (37) the flat bushel case, 26 by 14½ by 6 inch inside measurement, is considered suitable.

For South African tomatoes (55, 56, 58), packing with peat-mull (moss-litter) has been recommended. Ripe fruits packed in peat-mull are reported to retain their attractive appearance and hard skins ; there is little evaporation and flavour is retained. Ripening is accelerated when fruits are packed in this way ; unripe fruits will ripen without shrinkage. In properly moistened, loosely spread peat-mull, fruits ripen to an attractive colour and may gain in weight. Peat-mull also possesses certain chemical properties which prevent the spread of disease by contact. Mulder and Sprenger (35) also advocate the use of peat as a packing material.

In wrapping experiments with (i) ordinary plain paper, (ii) moisture-proof transparent cellulose, and (iii) plain, non-moisture proof transparent cellulose, Caruso and Harvey (9) observed least loss in weight in (ii) but the accumulation of moisture within the wrapper was considered undesirable for tomatoes not superficially disinfected. The use of moisture-proof wrappers hastened colouring, presumably because of the retention of gases and/or volatile substances. When subjected to an atmosphere containing one part of ethylene per 1,000 parts air, no marked difference in the rate of ripening was observed in fruits wrapped in the three wrappers. At a constant temperature of 5°C. (41°F.) superficially sterilised tomatoes kept better in the moisture-proof wrappers. The use of these wrappers also retarded the spread of contact moulds.

Transport by Rail.

Where transport by rail from warm to cold regions is involved (*e.g.* from Florida to northern markets), Sando (50) states that refrigerator cars without ice, but with good ventilation equipment are preferred by growers, the ventilators being adjusted to suit weather conditions.

Rapid Cooling.

In handling tropically-grown tomatoes intended for export, Wardlaw and McGuire (60) have recommended that the time between harvesting and cooling to the temperature of storage should be as brief as possible. Fruit not only depreciates as a result of wilting and ripening at high temperatures, but fungal pathogens make rapid inroads. Overholser and Moses (36) have called attention to the variations in fruit temperature which may occur according to the time of day at which picking is carried out and to the importance of pre-cooling consignments.

Interruption of Cold Storage.

The important question of the effect of exposing cold packs to tropical temperatures during transference from a pre-cooling station to the ship's holds has been considered (60). It was found that the exposure, for four hours at 80° to 85°F., of standard tomato packs, previously held at 45°F., resulted in no perceptible modification of the subsequent storage behaviour. During the period of exposure to tropical conditions, a considerable amount of condensation moisture accumulated on marginal packs, but this soon disappeared when the packs were subjected to air-blast refrigeration; the individual fruit wrappers were quite unsoiled and showed no tendency to adhere to the fruit. Protection of crates during transference from cold rooms to the ship's holds is desirable to avoid undue loss of refrigeration. Various devices, including the use of insulated blankets, may be applied to overcome this difficulty.

Storage and Ripening Temperatures.

From a survey of the literature on tomato storage and ripening temperatures, it is evident that fruits grown in different regions show marked differences in their response to low temperatures, and that considerably different systems of preservation have been adopted by different investigators. Thus, according to some workers (51), the best means of preserving tomatoes in the fresh state consists in holding ripe fruit at 32°F., *i.e.*, close to its freezing point, whereas other observers have indicated more or less severe physiological injury to ripening fruits held for more than a few days at low temperatures, the optimal storage temperature being in the region of 55°F. It now appears that both sets of observations can, to some extent, be reconciled, provided attention is given to (*a*) the effect of environment and pre-storage factors on keeping quality, and (*b*) the relation between temperature, maturity and ripening processes of fruit in storage.

Storage at Low Temperatures.—Rasmusson (44) has recorded the successful storage of ripe tomatoes for two months at 32°F. ; Plank and Schneider (38) also obtained storage for four to five weeks with ripe fruit at 32°F. and a R.H. of 85 per cent. but observed that wastage took place rapidly on removing fruit from cold storage. Similar conditions have been cited by Schneider and

Scupin (51). According to Adam (1) tomatoes, picked three-quarters ripe and stored at 33° to 34°F. in ventilated chambers with low relative humidity, could be held satisfactorily for three weeks. Wright *et al.* (64) consider that ripe fruit may be held at 32°F. for eight to ten days provided they are intended for immediate consumption on being removed from cold storage. Barker (4) has stated that storage of ripe fruit at 34°F. might be recommended for the preservation of tomatoes as ships' provisions.

Storage at Higher Temperatures.—Recommendations for storage at comparatively high temperatures have been made in most of the principal tomato-growing countries.

United States.—For the storage of fruit picked full-grown green (green mature), or slightly colouring, a considerable body of experimental work indicates that a temperature of approximately 55°F. is most suitable (16, 39, 45, 37, 50, 64). At this temperature the rate of ripening and fungal wastage are both comparatively slow and a storage life of two to four to five weeks is assured, with the possibility of further storage for a week or more during distribution at 70°F.

Experiments carried out by Rosa (47), may be cited to indicate in greater detail the behaviour of tomatoes at different temperatures. The most rapid ripening of full-grown green tomatoes was obtained at 77°F.; at 86°F. a marked retardation of colouring was observed; at temperatures below 77°F. ripening was also retarded. Both colouring and the chemical changes which accompany ripening were slow at 52°F. and were almost completely inhibited at 39° to 46°F.; fruits stored at the lower temperature range also showed retarded colour development on being removed to the ripening room subsequently. High wastage was the rule in fruits which had been held at low temperatures, the wastage being in proportion to the duration and lowering of the temperature of storage. Rosa considers a temperature of 53° to 59°F. to be optimal for tomato storage, and cites the following (mean) number of days to ripen the Stone variety at the several temperatures: 52°F., 24 days (31 per cent. fully coloured, 21 per cent. partly coloured and 48 per cent. decayed after 40 days); 61° to 64°F., 16 days; 77°F., eight days; 86°F., 11 days. "Turning" tomatoes of the Stone variety stored at 46°F. became red in about 18 days, but were subject to breakdown on removal to a higher temperature; similar fruit stored at 39°F. showed no colour change at all. Similar records have been cited by Platenius *et al.* (39) and Haber (16). The latter states that ripe fruits held at 50°F. changed but little in the course of five weeks and remained in good condition on being transferred to room temperature.

England.—Barker (4), working with green and fully coloured English hot-house tomatoes (Riverside and Manx Marvel varieties) is of the opinion that prolonged cold storage is not feasible; fruits were injuriously affected by more than brief exposures to temperatures below 50°F., injury being indicated by failure to develop normal colour and by abnormally rapid decay on removing fruits to a higher temperature. Periods of four days at 34°F. were conducive to chilling injury. Tomatoes were also injured at 40° and 50°F. From experimental records he suggests that the optimal storage temperature lies in the vicinity 55° to 60°F.

Holland.—In a comprehensive study, Mulder and Sprenger (35) have described the behaviour of tomatoes of different maturities, from immature green to ripe red fruits, held at temperatures ranging from 32° to 77°F. They have confirmed the earlier investigations of Diehl and Rosa regarding the operation of the time factor in the production of chilling at 32°F. in unripe fruit (*see* Low Temperature Injury): entirely red fruit, on the other hand, could be stored at this temperature for four weeks without developing symptoms of physiological injury; on removal from storage this fruit, however, was not of the first quality. At 39°F. the behaviour of fruit was also abnormal; slight evidence of low temperature injury was also observed at 46°F. after two weeks in storage. At 50°F. storage behaviour was approximately normal, and at 52°F. no symptoms of internal breakdown were observed, even after long periods in storage. A temperature of 54°F. is considered to afford definite freedom from chilling. At 59°F. the ripening colour obtained was a marked improvement on that obtained in fruit exposed to lower temperatures. Mulder and Sprenger have also confirmed the results of other workers that immature green fruits are most subject to low temperature breakdown. In storage at 54°F., fruits showing just the first trace of colour give the longest storage life; such fruits may safely be held in storage for four weeks.

South Africa.—In a consignment of South African tomatoes, packed at various stages of maturity, and transported at a temperature of 40° to 44°F. during a voyage period of approximately 29 days, the fruits, on being discharged appeared to be in good condition but soon became wasty. It was considered that some chilling had taken place *en route* (55).

New South Wales.—Tomatoes grown in certain districts, if picked green, are reported as being capable of being held at an average temperature of 50°F. for two months (11), the fruit gradually ripening in storage. In storage trials with green fruit of the Bonnie Best variety at 34°F., shrivelling of the skin was noted at the end of four weeks and complete breakdown after six weeks.

Storage of Tropically-Grown Fruit.—In relation to the development of an export tomato industry from West Indian Islands to Canada, Wardlaw and McGuire (60) made an extensive series of trials with different varieties over a considerable temperature range. In marked contrast to the results of other investigators (quoted above) it was ascertained that tropically-grown tomatoes, picked full-grown green, can be held satisfactorily

at temperatures from 41.5° to 50°F., without chilling injury being apparent during storage periods up to 30 days. Fruit held at these temperatures ripened slowly during cold storage and later ripened normally on transference to a temperature of 70°F. In relation to (*a*) the duration of local storage, overseas transport and marketing, (*b*) marketing requirements in respect of maturity, and (*c*) control of wastage, a storage temperature of 47.5°F. was recommended. Lower temperatures, *e.g.*, 45°F., which would permit of the export of colouring fruit, may also be used. In general, the storage results recorded in Trinidad compare favourably with those previously obtained from fruit grown under more temperate conditions: the better grades of fruit were repeatedly held in cold storage (41.5° to 50°F.) for 20 days or more, with a further storage life at higher temperatures, 65° to 70°F., of ten to 14 days, with low wastage. Chilling was not observed at temperatures above 40°F. In other experiments (59) Bonny Best tomatoes were held at 45°F. for 41 days without developing chilling injury. Shipments of tomatoes from Montserrat (25) and other West Indian islands, under the conditions specified above, have now been successfully made for many years.

Following the work of Wardlaw and McGuire (60), in which considerable tolerance of low-temperatures was demonstrated for tropically-grown tomatoes, Kidd and West (22) carried out storage trials with English hot-house tomatoes grown in the height of summer and in autumn. It was found that, whereas autumn-grown fruit confirmed Barker's (4) earlier results, viz.: that English tomatoes require a storage temperature of 55° to 60°F., the summer-grown fruit showed considerable tolerance of low temperatures. Thus in summer-grown fruit stored at 41°F. there was no wastage after 30 days, and on removal to 59°F. the fruit slowly ripened; wastage developed in the normal way, reaching 50 per cent. on the 57th day (*i.e.* 26 days after removal from cold storage). Fruit held at 64.5°F. from the outset showed wastage as from the 18th day.

In autumn-grown fruit, on the other hand, wastage was observed after 15 days at 59°F., and reached 50 per cent. in 27 days. At 41°F. characteristic sharply defined watery blisters, filled with *Botrytis cinerea*, were already in evidence after ten days, and at 50°F. after 15 days. No hypothesis has been advanced to suggest why summer-grown fruit should tolerate low temperatures better than autumn-grown fruit.

Low Temperature Injury.

For many years the view was held among tomato dealers that full-grown green fruits, if cooled, even for short periods, to low temperatures (but not necessarily frozen) would not ripen normally when later placed at higher temperatures. It was considered that such chilled fruit, as well as showing symptoms of physiological injury, would fail to develop their attractive red ripening colour. The work of Diehl (12) and other investigators has done much to clarify the position with regard to the effect of exposure to low temperatures on tomato ripening and wastage.

Diehl (12) found that full-grown green and colouring tomatoes, held at 30° to 31°F. for one day, subsequently ripened normally at 70°F., showing that brief chilling, in the absence of ice-formation in the tissues, did not induce physiological breakdown. Storage at 32°F. for four days had likewise no ill effect on subsequent ripening, but storage at 32°F. for eight days or longer resulted in breakdown when fruits were removed to a higher temperature. Diehl also showed that fruits could be cooled below freezing point for a short period without apparent injury provided they were not allowed to freeze. Similar results have been cited by other workers (2, 64).

Rosa (47) has also carried out some experiments to determine the effect of temperatures higher than those employed by Diehl, but low enough to exercise a marked retardation of ripening processes. Comparable lots of the Stone variety were held at 39°, 46° and 54°F., for 4, 10, 15 and 25 days with subsequent removal to a room at 77°F. It was found that four days at 39°F. resulted in delayed ripening after removal to 77°F.; the more prolonged the period of exposure at low temperature the slower was the rate of ripening subsequently and the greater the wastage (breakdown and decay). Thus after 25 days at 39°F. all the fruits decayed on removal to 77°F., without any evidence of ripening colour appearing. Somewhat similar but less marked effects were observed in fruit held at 46°F.

The view has been advanced that the disorganisation of the ripening mechanism may be due to the inactivation of the enzymes, particularly those connected with the oxidase system. From Rosa's results with the Stone variety, grown under Californian conditions, it would appear that storage for ten days at 40° to 45°F. is critical in the production of chilling injury. Rosa considers that temperature conditions in the field may be important in this connection (*see* Pre-storage Factors).

The effect of low temperatures on ripe fruit is quite different from that described above for green fruit. Thus, as already mentioned, Plank and Schneider (38) and other workers have reported the successful storage of ripe fruit for various periods at 32°F.

A more recent account of the effect of exposure to low temperatures on the subsequent ripening of tomatoes has been given by Wright *et al.* (64). Lots of full-grown green Globe and Marglobe fruits were held at 32°F. for 1, 2, 3, 4 and 8 days with subsequent ripening at 70°F. and a R.H. of 85 per cent. No great difference was observed in the rate of ripening of fruits exposed at 32°F. from one to four days, and the ultimate

ripening of fruits was not prevented by such exposure. An 8-day exposure, however, resulted in a pronounced retardation of ripening (*e.g.* ripening was only observed in 31 per cent. of the fruits after 11 days at 70°F. whereas in lots held at 32°F. for one to four days 100 per cent. ripening had taken place) and breakdown of green fruits.

Wright *et al.* have shown clearly that while the exposure of green tomatoes of various maturities to low temperatures retarded subsequent ripening at a higher temperature, normal ripening was not necessarily prevented. Even specimens which had suffered chilling or freezing injury ripened up with normal colour, except in the injured areas which tended to remain green or became mottled. Chilling symptoms were less conspicuous in full-grown green fruits than in those harvested at a less mature stage. Tomatoes stored at 40°F. for 11 to 15 days and then transferred to a higher temperature showed delayed ripening but otherwise were normal in appearance and behaviour. If stored at 50°F. for 14 to 18 days, normal ripening on removal to a higher temperature was the rule.

Symptoms of Chilling.—Chilling injury is indicated by the presence of numerous small pits or sunken areas over the surface of fruits. Affected fruits have been described as possessing a glazed, glassy or shrivelled appearance (35); ripening colour may be either absent or imperfectly developed in the vicinity of chill blemishes. Chilled fruits are subject to rapid wastage on being removed to higher temperatures.

In a recent investigation of chilling in tomatoes Banga (3) found no abnormal change in sugar metabolism as a result of exposing fruits to low temperatures. It has been seen that in normal green tomatoes acidity is on the increase up to the point when colouring begins to be apparent; when this stage has been reached the acidity decreases. Green fruits which have been chilled do not show this increase in acidity, a gradual decrease being the rule. Changes in rates of respiration which result from chilling have been attributed by Banga to the changes induced in the acid metabolism.

Loss in Weight.

Tomato fruits show a small but continuous loss in weight in storage, the amount of this loss being influenced by temperature, humidity and the presence of superficial cracks, cuts and bruises. The higher the temperature, and the longer the duration of storage, the greater is the loss in weight. High rates of water loss are the rule immediately after harvesting. Although the decrease in weight of fruit in storage is chiefly due to transpiration, losses in organic constituents, particularly sugars and acids, also take place. Where sugars and acids are lost in different proportions, quality changes may become apparent, *i.e.* fruits may be sweeter or more acid. According to MacGillivray (26) fruits held at 57°F. lose acid more rapidly than sugars. Changes in acid and sugar content are also reflected in the flavour of the solid tissues of the fruit.

With tomatoes of the Bonny Best and Marglobe varieties, picked full-grown green, Platenius *et al.* (39) have recorded a loss in weight of about ten per cent. during 30 days' storage both at 49° and 70°F., the rate of shrinkage being greatest during the first few days.

In crates of tropically-grown tomatoes, picked full-grown green, wrapped, and held at 47.5°F.—the temperature recommended for transport—and a R.H. of 90 per cent., a loss of 4.5 per cent. by weight was sustained in the course of 20 days, and a further 3.0 to 3.5 per cent. in the course of five days at 70°F. with a R.H. of 80 per cent. (60).

Effect of Light on Ripening.

Wright *et al.* (64) have briefly described some experiments on the effect of light and darkness on ripening. While the actual rates of ripening were approximately the same, considerable differences were noted in the appearance of the fruit. Tomatoes ripened in the dark showed a more even distribution of colour from green to whitish and then to pink, followed by a full red colour as ripening progressed: in tomatoes ripened in full light, there was a sharp contrast between the full red colour at the distal or blossom end and the full green colour at the stem end. Similar observations have been recorded by Platenius *et al.* (39). Morgan and Smith (32) have observedt hat ripening colour develops more quickly in diffuse light than in the dark.

Sulphur Dioxide Injury.

Sulphur dioxide gas is sometimes used as a means of controlling wastage in tomatoes during transport. Ramsey (41) and Ramsey and Link (43) have described the occurrence of a special type of wastage due to the use of sulphur dioxide fumes in railcar transport of tomatoes.

"The injury results from burning sulphur in cars of tomatoes, or using sulphur dioxide gas, as is practised with certain commodities in California, to reduce the amount of decay during transit and marketing. No experimental data are available, however, to show that sulphur dioxide is of value in reducing decay in cars of tomatoes.

"The tomatoes affected show a very pronounced sinking and drying out of the tissues at the stem scar. The gas enters the fruits through the stem scars or through wounds elsewhere on the surface. The cells immediately surrounding the openings are killed and lose their water rapidly by evaporation, causing collapse of the affected region. In some instances the stem scar is sunken one-half inch and the tissues immediately around the scar are bleached to a sickly greenish-tan color, while the remainder of the tomato remains normal except where mechanical injury is evident.

Wherever the cuticle and epidermis of a fruit show a wound, the surrounding tissues are sunken and bleached greenish-tan like those around the stem end. The sunken stem scars dry rapidly and crack, thus opening the way for various decay-producing organisms, such as Alternaria and Rhizopus." (43).

Ethylene Ripening.

By the use of ethylene the time required for ripening green tomatoes can be greatly reduced and the quality of the fruit improved over that usually obtained by exposure to high temperature alone. This is important commercially in those marketing centres where fruit, imported from distant agricultural areas in bulk, frequently arrives in a green or very green condition. The application of ethylene, under properly controlled conditions, causes green tomatoes to take on a bright red colour in the course of four to six days, *i.e.* ripening can be accelerated to suit market requirements; turning fruits, on which the ethylene treatment is most effective (23), require less time. Slowly ripening immature fruits which tend to be flavourless, may be improved by the more rapid ripening resulting from ethylene treatment (47); ethylene treatment of tomatoes results in both colour changes and ripening of the flesh.

Marloth (31) referring to South African fruit, has pointed out that during the winter months, when tomatoes do not colour well on the vines, there tends to be a glut of green fruit and a shortage of well-coloured, ripe fruit. This can be readily overcome by the use of ethylene. In general it may be said that the ethylene ripening of tomatoes has now a wide commercial application in those countries where production and marketing are on an extensive scale (17, 19, 46, 47, 63).

The first systematic work on the colouring of tomatoes by ethylene and other organic compounds was carried out by Rosa (46, 47). Propylene was found to be more effective than ethylene. Ethylene dichloride and ethylene chlorohydrin were not effective, the latter compound being toxic to tomatoes.

Rosa has shown that ethylene, applied at concentrations of 1 in 800 to 1 in 4,300 parts of air, gives definite acceleration of ripening. Propylene at a concentration of 1 in 5,000 parts of air, applied at 77°F. for two to six days, gives still more rapid colouring of green fruits. The fruits should be removed from the gas chamber when they have reached the "pink" stage; thereafter colouring is completed rapidly at ripening room temperatures. Fruits which fail to develop pink colour at the end of six days of gas treatment should be discarded.

Harvey's (17, 18) investigations and published illustrations show that whereas normal colouring on the vine begins at the distal end of the fruit, ripening in ethylene treated fruit begins at the stem-end; he concludes that this indicates the entry of the gas into the fruit. This observation has not been confirmed in experiments carried out by Kohman (23), who records colouring in green fruit, exposed to ethylene, as beginning at the stylar end in the usual way.

Very immature tomatoes may be ripened by ethylene treatment in the course of six to eight days but the use of such fruit for marketing is not recommended. The conditions advised for the ethylene treatment of tomatoes by Harvey are a temperature of 65° to 75°F., a R.H. of 80 to 90 per cent., and ethylene supplied at the rate of one part per 1,000 parts of air; higher concentrations may be harmful; they also retard ripening.

In studies of the ethylene ripening of tomatoes, Hibbard (19) has concluded that there is little evidence that ethylene increases the sweetness of the fruit. Cognate observations show that vine-ripened fruits have a higher sugar content than green fruit or artificially ripened fruit; no significant difference was observed between air and ethylene ripened fruits. This is at variance with Rosa's finding that ethylene-ripened tomatoes are sweeter than air-ripened fruits. Hibbard concludes: "It is questionable whether a harvested green mature tomato can ever be made appreciably sweeter by any artificial ripening process when it is known that it lacks an extensive carbohydrate reserve. It is thus apparent that ethylene gas has its chief practical value when it is used in hastening colour formation".

House, Nelson and Haber (20) found no injurious effect on vitamins A, B and C as a result of ethylene ripening. Morgan and Smith (32) have shown that vitamin A increases in the tomato from the green to the ripe stage whether fruits are vine or artificially ripened.

Clow *et al.* (8) have recorded that ethylene ripened tomatoes are richer in Vitamin C than green fruits, but not quite so potent as fruit thoroughly ripened by standing at room temperature until the tissues have become considerably softened. They also noted that ripe greenhouse tomatoes do not usually contain as much vitamin C as field-ripened tomatoes. This is chiefly a question of the maturity at which the fruit is used: fully ripened greenhouse tomatoes give results comparable to those obtained from field-ripened fruit. Green fruit ripened at 70°F. after picking appears to contain as much vitamin C as vine-ripened fruit.

Mulder *et al.* (34) record that they obtained no acceleration of tomato ripening by exposing fruits to an atmosphere containing one part ethylene in 1,000 parts air at a temperature of 25° to 26°C. (77° to 79°F.) and a R.H. of 85 to 95 per cent.

Gas Storage.

In some early observations Sando (50) came to the conclusion that tomatoes stored without adequate ventilation were inferior in quality to fruit ripened in air (*See* Chemical Changes, &c.). More recently Kidd and West (21) have described experiments in which comparable lots of hot-house tomatoes, picked "yellow" and "tinted", were stored in air at 64.4°, 59°, 53.5°, 47.5° and 41°F., and in artificial atmospheres containing 2.5, 5 and 10 per cent. oxygen with 0, 5 and 10 per cent. carbon dioxide (the remainder being nitrogen), at 60°, 53.5° and 47.5°F.

The maximum storage life in air was obtained at 53.5°F.; at lower temperatures chilling injury was sustained. The effect of exposing fruit to the several gas-storage conditions was to cause a retardation of the colour change; this occurred both at decreased O_2 concentrations and increased CO_2 concentrations. The most effective *retardation*, as distinct from actual *preservation*, was obtained in a gas mixture containing 2.5 per cent. of O_2 and 10 per cent. of CO_2. The best preservation results were obtained at a temperature of 53.5°F. in an atmosphere containing 5 per cent. of oxygen and 5 per cent. of carbon dioxide; higher percentages of CO_2 had an injurious effect, this being more pronounced the lower the temperature.

Brooks *et al.* (6) have also recorded a retarding effect on the ripening of tomatoes as the result of treatment with CO_2; this was more marked in green and turning fruit than in pink coloured fruit. As a rule treated fruits were noticeably firm.

In gas storage experiments Thornton (57) found that tomatoes were very susceptible to the injurious effects of CO_2 when held in storage for any length of time. Fruits were injured at 32° and 50°F. by concentrations of 10 per cent. CO_2. "The gas tended to bring about a complete softening of the carpel walls resulting in a watery mass of abnormally flavoured pulp enclosed in a somewhat tough skin. The riper the tomato the greater was the carbon dioxide injury."

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Topepo.

The topepo, derived by crossing a tomato and a pepper, has an orange-coloured fruit, turning deep red at final maturity; the inside looks like a pepper but the seeds are those of a tomato. This fruit is said to possess an appetising condiment flavour (2). Fruits held without refrigeration for 18 days showed only slight shrivelling. McGuire (1) has suggested 50°F. as a suitable temperature for experimental trials.

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Tree Tomato.

The transport of the fruit of the tree tomato (*Cyphomandra betacea*), from Java to Holland in refrigerated chambers at 3°C. (37.4°F.) has been attempted. The fruit has no commercial value or reputation on temperate markets.

Reference.

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Water-Cress.

Watercress (*Nasturtium officinale*) may be carried at a temperature of 33° to 35°F. and R.H. of 80 to 82 per cent.

Yams.

Yams (*Dioscorea alata* and *D. spp.*) are important locally as a food crop in many parts of the tropics. The tubers are ready for digging when the foliage has become dry. While dry weather persists the tubers may be left in the ground. For storage, yams should be lifted carefully to avoid bruising (1, 2). The tubers should be left exposed for a few hours and then stored on shelves in a cool, well-ventilated room. Buds and eyes should be removed as soon as they show signs of sprouting. Under favourable conditions, and provided bruised or cut surfaces have been treated with white lime or ashes, yams may be held in common storage for several months, provided regular inspection is carried out so that diseased tubers may be removed. Williams (1) records a loss in weight of 14.5 per cent. during three and a half months' storage. So far, little attention has been paid to such tropical root crops from the point of view of cold storage.

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ADDENDA.

Cassava.

The tubers of the cassava or manioc plant (*Manihot utilissima*) do not store well for any length of time after removal from the ground. In various dried forms the tubers may, however, be kept for long periods (1).

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Langsat.

While the langsat, lanzone, ayer-ayer or duku (*Lansium domesticum*) cannot, according to Popenoe (1) be said to rival the mangosteen, it may nevertheless be considered one of the best fruits of the Malayan region. "Like the mangosteen it differs from many other tropical fruits in being juicy and of aromatic sub-acid flavour, instead of richly sweet . . . The fruit varies in form and character, but is generally oval or round, one to two inches in diameter, velvety and straw coloured, with a thick leathery skin enclosing five segments of white, translucent, juicy, aromatic flesh and one to three large seeds."

The tree is cultivated in the Malay Archipelago and in the Philippine Islands; outside the Asiatic tropics it is only to be seen in botanic gardens and private collections.

An account of the storage requirements of langsats has recently been published by San Pedro (2) using fruit grown in the Philippine Islands.

Under ordinary conditions the langsat, having reached eating ripeness, does not remain in marketable condition for more than four days. Furthermore, as San Pedro points out, it is a short season crop, the total production period being about one month.

Effect of Maturity at Harvesting on Flavour and Keeping Quality.

When ripe, turning and green fruits were held at ordinary (tropical) temperatures, 85° to 90°F., ripe fruit remained in good condition for three days, whereas turning fruit, showing approximately 50 per cent. colour, failed to ripen normally, both colour and flavour being affected; most of the green fruit decayed before becoming 50 per cent. coloured. On this finding only ripe fruit was used in cold storage experiments.

Storage Temperature.

In storage trials, at temperatures ranging from 32° to 80°F., the best results were obtained at 55° to 60°F., the fruit remaining in good condition for 13 days with only 9.5 per cent. wastage; this increased to 50 per cent. by the 16th day; at lower temperatures chilling injury, in the form of brown blotches, with a water-soaked appearance, distributed over the skin, was the rule; at higher temperatures the storage life was shorter and the onset of wastage more rapid.

In fruit stored at 55° to 60°F. there was little change in the dry matter and total sugar content; there was an increase in specific gravity and in reducing sugars, and a decrease in titratable acidity.

By covering fruits with sawdust at ordinary tropical temperatures, the normal storage life was extended from three to seven days, 25 per cent. wastage being sustained.

Quick cold storage after harvesting is essential for the successful handling of this fruit.

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SPOTTING OF BANANAS CAUSED BY *FRANKLINIELLA INSULARIS* (Franklin).

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It may be desirable to place on record the following curious instance of the effect produced by modifying agricultural practices on the host-pest relationship.

In St. Vincent the cultivation of Gros Michel bananas on a commercial scale was commenced in 1934 and at the end of 1936 about 1,000 acres had been planted. It was noticed early in December 1936 that a large number of stems delivered to the Co-operative Banana Association for export from some of the more recently planted areas were badly spotted. In subsequent fortnightly shipments, the amount of spotting increased and the number of stems which had to be rejected for this reason was considerable, as will be seen from the following figures showing the number of stems accepted and rejected from fruit delivered to the Association by one estate, for three consecutive fortnightly shipments:—

Stems accepted.	*Stems rejected on account of spotting.*
0	45
11	51
16	134

Valuing the above rejects at 35 cents (70% counts) it will be seen that the loss amounted to $80.50. On another estate even greater losses were sustained and at one time it appeared likely that the cultivation of bananas on these two estates would have to be abandoned.

Fortunately, however, when the problem had been thoroughly investigated effective control measures readily suggested themselves.

The appearance of the affected fruit is very remarkable, and the spots which are brown or jet black and which may be as many as 30 to the square inch, resemble the marks that would result if the surface of the fingers had been pricked all over with a needle. The blackening of the spots is evidently due to a slight exudation of sap which turns black on exposure to air. The spots are sometimes surrounded by a small water-soaked halo, and after a time may become brown owing to the formation of corky tissue. The blemishes are serious enough to disqualify the fruit but the spots are superficial and do not penetrate far beneath the epidermis.

To discover the cause of the spotting an inspection of affected plantations was made by the writers together with Mr. C. K. Robinson of the Agricultural Department in St. Vincent. No possible causal agent was discovered on the bunches approaching maturity, but it soon became evident that the damage was caused at a very early stage as the spotting was traced back to very young fruit still enclosed by the flower bracts. When the bracts were raised numerous thrips in all stages of development were found, and the surface of the fruit was covered with minute, slightly raised greyish-brown spots which on microscopical examination proved to be the egg-pits of thrips, each of which contained one egg. Eggs were found in fingers up to about four inches in length.

The eggs are approximately pear-shaped but flattened on one side. The pointed end protrudes through the epidermis and is occupied by the head of the embryo, the red eyes of which may easily be recognised. The egg-pit has a halo of reacting cells which become turgid and somewhat enlarged which perhaps accounts for the unusual shape of the egg. In the case of most Terebrantia the shape is reniform. The tendency of the reacting cells would be to render the enclosed part of the egg globose.

On one estate the spotting was worst in an area of about four acres where the bananas had been interplanted with sword beans, *Canavalia ensiformis*. Just outside of this area the spotting was not quite so severe and further away it was markedly less. At a distance of about 500 yards from the *Canavalia* plants there was extremely little spotting, and practically no thrips were found on the fruit inside the flower bracts.

On the other estate where spotting also occurred either sword bean plants or *Gliricidia* trees were plentiful. At a third a few stems in close proximity to a *Gliricidia* tree were badly spotted. At a fourth where there was a mixed cultivation of bananas, plantains and pigeon peas, *Cajanus indicus*, the fruit of both the bananas and plantains were badly spotted.

In every case the sword beans, the *Gliricidia*, and the pigeon peas, as well as the affected bananas and plantains proved to be heavily infested with the common West Indian flower thrips *Frankliniella insularis* (Franklin)*. This well known cosmopolitan insect was first recorded in

*The material was kindly identified by the Imperial Institute of Entomology.

Besides *F. insularis* which greatly predominated and which is the only species common to the banana and the leguminous hosts, he following minor species were found:—

Frankliniella cephalica Crawf. on *Gliricidia*.

Frankliniella sp. } on banana.
Echinothrips mexicanus Moulton. }

1908 from St. Vincent and Barbados. It has a vast range of food plants but it is most commonly found on legumes such as *Dolichos*, *Canavalia*, *Cajanus* and *Gliricidia*. When ovipositing, the female thrips always inserts its eggs into some soft plant tissues and in the case of legumes the eggs may be seen in the tissues of the petals by examining the latter against the light with a lens. Several dozen heavily infested sword bean flowers from the cultivation on the first estate were examined, but no eggs could be seen. At the same time numerous eggs were found in *Canavalia* flowers obtained from plants grown in other parts of the island where relatively few bananas or plantains are cultivated.

It was therefore concluded that the adults of *Frankliniella* though not apparently feeding to any extent on the expanded fingers, had selected the young fruit as an ovipositing medium. The young bunches by reasons of their sheltered position and succulence certainly appear to furnish the thrips with an ideal and inexhaustible breeding ground. It is evident, however, that the thrips do not stray far from their leguminous host plants.

The type of damage described has been found to occur in wet districts during the wet season, and also in some of the drier districts during the dry season. The two estates where most of the damage occurred are in the North Windward and North Leeward districts respectively, both of which are fairly wet.

Acting on the advice of the Agricultural Department the owners of the first estate destroyed all the *Canavalia* plants growing among the bananas. This was immediately followed by a reduction in the amount of spotting of the young fruit. About three months later the spotting had almost completely disappeared, and the majority of the fruit produced, being clean, was accepted by the Association.

Subsequently, the estate again sent in a small quantity of fruit which was slightly spotted, and it was found that a number of *Canavalia* plants had been allowed to reappear. The destruction of these resulted once more in a diminution of spotting.

In conclusion it is recommended that sword beans, *Gliricidia* and pigeon peas, and other plants likely to harbour the thrips should not be grown in any quantity in or near banana fields.

REVIEWS.

Report of Thirteenth Annual Date Growers' Institute, Coachella, 18. 4. 36 California, *Coachella Valley Farm Center*. pp. 18, 6 tables, February, 1937.

The annual reports of the Coachella Valley Date Growers' Institute which form the only periodical in the world devoted entirely to the problems of date culture should be of particular interest to date growers. Nine papers were read at the Institute which are briefly summarised below.

The work done by the United States Department of Agriculture and which covers research activities on pollination, thinning, storage, handling, cover crops, soil moisture, fertility and varieties was described by K. A. Ryerson, Principal Horticulturist in Charge of Sub-tropical Fruit Investigations. He also stated that *Parlatoria* scale had been eradicated.

D. E. Bliss, Assistant Plant Pathologist, University of California, Citrus Experiment Station, Riverside, briefly described Rhizosis, a usually fatal root rot of date palms caused, it would appear, by a new fungus discovered by Dr. Bliss, *Ceratostomella* sp. No cure has been found.

R. W. Nixon, Associate Horticulturist, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, who has continued his thinning experiments with Daqlat an-Nur palms, discovered that it pays to cut off half the flowers at pollination.

V. H. Dowson, Director, Kut as-Sayyid Estate, compared cultural practices in different parts of the world and suggested climatic, and other reasons for differences between them.

L. D. Rachelor, Director, Citrus Experiment Station, Riverside, described the work of his station on dates which covers the study of problems in the plant pathology of dates, manuring, and in the duty of water.

T. W. Braun, Director, California Date Growers' Association, estimated that by marketing nearly all the Californian date crop of 8,000,000 lb. through one organization, the costs would work out approximately as follows:—

8.6	cent a lb.	to grower,
3.2	do.	packing house expenses,
0.5	do.	advertising,
1.5	do.	sales expenses,
2.0	do.	transport and storage,
10.0	do.	brokers' and retailers' discount.
25.8		

He was of the opinion that the bulk of the crop (65%, say, 5,200,000 lb.) could be sold retail at about 27c. and that 15% of the crop, or about 1,200,000 lb., might be expected to be of first quality and might be retailed at 50c. a lb. or wholesaled at 27c. Until by-products could be found to dispose successfully of the 20% low grade dates, amounting to about 1,600,000 lb., he recommended destroying them.

W. R. Barger, Associate Physiologist, Division of Fruit and Vegetable Crops and Diseases, summarized his experiments in hydrating dry Daqlat an-Nur dates. Hydration softens the dates and makes them syrupy, adds to their weight and water content, and converts much of the sucrose to invert sugar. The higher the temperature and the greater the humidity of the surrounding air, the quicker the dates become hydrated.

F. A. Tackery and G. H. Leach, U.S.D.A. Date Experiment Station, Indio, reported on the progress made with trials of cover crops for date palms. Tepary Bean and Sudan Grass so far look promising.

R. H. Postlethwaite, M.I.E.E., explained a method for the rapid determination of the sugar content of dates, depending on the following axiom: the specific gravity of a mixture is the sum of the products obtained by multiplying the specific gravity of each constituent by the fraction representing the proportion of that constituent to the whole. The three constituents of dates are taken as sugar, water and marc, the specific gravity of all of which is known. The water content is estimated by the method of Sievers and Berger. Marc is considered to be everything which is not sugar and water. The specific gravity of the dates is found by dropping them into sugar solutions of different densities. The one unknown, namely the proportion of sugar in the date, can then be readily calculated.

V.H.W.D.

* * *

APPLICATION OF STATISTICAL METHODS IN AGRICULTURAL RESEARCH.

By H. H. Love, Ph.D., *The Commercial Press, Ltd.*, Shanghai, 1936, pp. 502, $6 (Mexican).

This book does not purport to be an exhaustive treatise on statistical theory and practice. As the title implies, discussion has been limited to the application of statistical methods in the interpretation of research data, and no attempt has been made to demonstrate the derivation of the different formulae cited. In the field of applied statistics, the ground covered is extensive, and the examples given include problems on variation, correlation, curve-fitting, the analysis of variance and co-variance and on field plot technique. The examples have been carefully selected from actual experimental data, and effectively illustrate the calculations they are intended to exemplify.

As a guide to the elementary student of statistical technique in biological research, the first half of the book, describing frequency distributions, dispersion, correlation and the probable error concept is particularly good, the subject headings being discussed in a simple yet effective manner that should present no difficulty even to the novice. It is suggested that more weight might have been given to the use of the standard error in preference to the probable error, in the interpretation of results. The second half of the book includes problems of a more complex character requiring a more intricate technique, and it is not altogether surprising that this section is not quite up to the high standard of excellence and general clarity of the first portion. Certain aspects appear to demand a more comprehensive treatment than the author has been able to devote to them. For example, the use of the number of degrees of freedom in the determination of the variance is a feature that frequently puzzles the beginner, and yet the space devoted to the explanation of this principle is very limited. The same criticism might be levelled at the author's treatment of interaction effects in an analysis of variance. Factorial experiments, the principle of orthogonality and confounding, and the problems offered by perennial crops do not appear to have been discussed. It is, however, hardly fair to expect any author to cover every aspect of experimentation in a relatively small book, and it is certain that, to many students of biometrical methods, the lucidity of the exposition and the wealth of illustration will make this book a very welcome addition to the available literature.

D. D. P.

* * *

AN OUTLINE OF CYTOLOGICAL TECHNIQUE FOR PLANT BREEDERS.

With a Foreword by Sir A. Daniel Hall, *School of Agriculture*, Cambridge, 137, pp. 14, price 1s. 6d.

As Sir Daniel Hall says in a brief foreword to this bulletin, a knowledge of cytology and some acquaintance with its technique has become essential to the plant breeder. The aim of the publication is to give an account of the standard methods used in plant cytology and it is based on practical experience with these methods rather than on a survey of the literature.

After an introduction dealing with the value of cytology in plant breeding and some general remarks on technique, the bulletin describes in turn the paraffin method, including staining with iron alum-haematoxylin and with gentian violet, the aceto-carmine technique (a method particularly useful for plant breeders) and smears with standard fixatives and stains. Hints are given on the use of the microscope and the bulletin concludes with a list of fixatives with formulae and a short bibliography.

While the bulletin has been prepared for the benefit of plant breeders, it is of course equally suitable for anybody wishing to learn these standard methods: the modest price (1s. 6d.) is worth mention in this connection.

* * *

OVERSEAS PLANT PRODUCTS.

By J. H. Holland, *Bale, Sons & Curnow Ltd.*, London, 1937. Price 6s.

This handy little volume fills a gap in our reference literature and will be particularly useful in those agricultural departments and research institutions which are continually dealing with technical enquiries. Botanists in such places know how frequently time is consumed in tracing the identity of plants referred to only by unfamiliar vernacular names. This is essentially a dictionary of commercial and vernacular names, from which the corresponding botanical names and families can be quickly found, together with brief notes on distribution and uses. It arose from Mr. Holland's own experiences in identifying economic specimens at Kew, and is published under the auspices of the Royal Botanic Gardens.

E. E. C.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

What the Indian Sugar Industry Lacks: The Need for Rationalisation.

In a letter, written a short while ago to the *Statesman*, of Calcutta, Dr. Francis Maxwell, who has made a world-wide study of the sugar industry sums up the situation as it exists in India to-day and suggests the steps needed to put the indigenous sugar industry on a sounder footing. We quote his communication below.

"There has been a good deal of pother lately about the increase of the sugar excise. Personally I believe that the policy, apart from the benefit accruing to Government in increased revenue, is a sound one inasmuch as it tends to have a steadying effect on the industry.

The origin of the troubles that have led up to the present state of the industry can, I think, be traced back to 1931 when protection was granted by an excessively high tariff. It resulted in a hectic and ominous rush to put up factories in order to reap big profits on the get-rich-quick idea and with insufficient foresight and care for the future. Nowhere has there been such a rapid and vast expansion of the sugar industry in such a short time as in India. Within two years of the granting of the tariff the number of factories rose fourfold and the output of sugar was trebled. To-day there are over five times as many factories as before the tariff. Moreover the majority of the mills, for no tangible reason, were huddled close together in one or two provinces in sub-tropical Upper India instead of spreading them over the whole country, especially in the tropical parts. Further in some of the post-tariff factories the plants have proved of inferior quality and deficient in operation, which gives rise to the supposition that they were purchased without adequate technical knowledge. Nor can it be said that many factories have been run and maintained in an efficient manner. In the circumstances it is not surprising that to-day the industry as a whole is neither efficient nor stable.

Another important aspect is the lamentable lack of unity and co-operation among the milling companies, the necessity for which is abundantly exemplified in other countries. Hence the irony of cut-throat competition in the sale of sugar with disastrous effect on prices instead of pulling together to keep up the market by utilizing the liberal tariff to the full. And as the prices of sugar fall so the factories tend to increase their production in order to decrease the cost of production. At present the total production seems about to exceed the home consumption. The increase in excise should, *inter alia*, have a wholesome effect on the rise of production. In this respect the principle of the imposition of this excise is sound, but even so further measures will be needed for the effective stabilization of the industry.

The pre-eminent problem is that of the control of production in accordance with capacity to sell. It may be expedient, as in other countries under similar conditions, that rationalization should be enforced by legislation. While, however, in sugar countries of longer experience all the factories are on practically the same level of efficiency, this can by no means be said of India. Therefore, the method of rationalization should be of such a nature as to stimulate the industry to put its house in order by greatly increasing its efficiency. To this end the output of individual factories might be restricted not merely on their ability to pass cane through their plant but also on their technical efficiency in the recovery of sugar".—(*Int. Sugar Jr.*, Vol. XXXIX, No. 465, 1937, p. 341.)

* * *

Organic Acids in Cane Juice.—*Toshiichi Tanabe.*

Cane juice extracted from POJ 2725 grown in Formosa, showed the presence of aconitic, malic, citric, and oxalic acids, but not of tartaric, lactic, succinic and fumaric acids. From 55 litres of the juice (extraction ratio about 40 per cent.) 6.1 grms. of aconitic acid (as pure crystal), 0.35 grms. of malic acid (0.46 grms. as diethylester), 0.034 grms. of citric acid (0.043 grms. as calcium salt), and a trace of oxalic acid were isolated. It is noteworthy that the aconitic acid content amounted above 90 per cent. of the total organic acids present. The presence of citric acid in the cane juice had never been reported before.—(*Inter. Sugar Journal*, Vol. XXXIX, No. 466, p. 401, 1937).

* * *

Glass from Bagasse.

Experiments have recently been carried out on the utilization of bagasse ash for the production of glass*, and one of the largest wineries in the Philippines is now turning out about 5,000 bottles daily, into the composition of which ash produced from bagasse enters wholly or partly. Another material which can be used for the same purpose is rice hull ash, which according to Dr. Salvador del Mundo† gives a whiter and purer ash containing less iron and manganese, and can consequently be used for the production of other than bottle glasses.

* *I.S.J.*, 1937, p. 118.

† *The Sugar Cane Planter*, 1937, 1, No. 11, p. 11.

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1. Recent Improvement in the Simple Clarification for Raw Sugar Production. J. G. Davies, Price 2*s*.
2. Sugar Cost Accounts. G. C. Skinner. Price 1*s*.

The above publications may be obtained on application to the Editor, *Tropical Agriculture*.

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Light and Nitrogen Fixation.

In a " Chemical Note " presented in the August number of this Journal (Vol. XIV, 1937, p. 247), some striking results obtained by Dr. N. R. Dhar were summarised regarding the photochemical production of soil nitrate from ammonia under sterile conditions. It should not be concluded from Dhar's results that this work has passed unchallenged by other soil investigators. Thus, Professor G. de Rossi of Perugia, Italy, in a paper published in the Transactions of the Third International Congress of Soil Science, Oxford, 1935 (Vol. I, p. 135) and entitled " Chemical Nitrification in Soil " states that " one must bear in mind the fact that, in Rao and Dhar's experiments, the formation of nitrates, which is the fundamental and outstanding feature in the nitrification process, has not been observed ". Further, de Rossi claims that, in his own work, " under perfectly normal conditions, ammonia, naturally existent in the soil, undergoes a process of oxidation till nitric acid is produced and this quite independently of any microbiological activities, *quite apart from any influence exercised by light* " (our italics). " The process, however, is particularly favoured by a *moderate degree of heat* " (such as is provided by the sun's rays);—in de Rossi's experiments, for temperatures up to 70°C. Thus a photochemical action may not be involved in the nitrification of ammonia to nitrite and nitrate in soils under sterile conditions where biological factors are suppressed. de Rossi's results do not preclude the possibility of the operation of some factor effecting catalysis, though the identity of this catalyst has apparently not been demonstrated.

* * *

Colour of Hydrangea Flowers.

It would perhaps be difficult to say whether pink or blue hydrangea blooms are the most popular for floral decoration, but the reliable production of blue-coloured flowers has long been a horticultural desideratum. Dr. E. M. Chenery (who was appointed in May, 1936, to the post of Soil Surveyor by the Government of Trinidad) has made an exact study of this question and his findings have recently been published (*J. Roy. Hort. Soc.*, 62, Pt. 7, 304-320, July, 1937). The paper considers the problem from historical and horticultural points of view, and also compares the influence of soil conditions with the physiology of the plant. From all sources of evidence, aluminium seems to be the element the presence of which induces a blue colour in the flowers, and not iron, as was at one time supposed. Analyses of blue and pink sterile flowers or petaloid sepals showed that aluminium was always greatly in excess of iron when the blue colour appeared. The anthocyanin from pink flowers would, however, form a blue delphimidin complex with both iron and aluminium ions.—(*Nature*, Vol. 140, No. 3538, pp. 326, 1937.)

Soil Erosion in U.S.A.

A recent note in *Nature*, referring to an illustrated article which appeared in the *Geographical Magazine*, states that more than ten per cent. of the total land area of the United States has lost more than three-quarters of its top-soil, and that a further thirty per cent. can be regarded as moderately eroded. In the Mississippi valley alone, 400,000,000 tons of good rich top-soil are swept annually into the Gulf of Mexico, and in that area twenty-five per cent. of the cultivated land has been stripped down to the subsoil and rendered useless for cultivation. A reduced yield of crops is the first sign of soil erosion, and this is generally countered by the use of fertilizers, which are, however, only a temporary remedy. A change in agricultural practice is required, and this is being carried out in some areas. Terracing, strip cropping, embankments along contours and other devices are being used, but most important of all is the reversal from one-crop cultivation to crop rotation and mixed farming. This, of course, will reduce the output of cash crops and mean a greater production of livestock products. The tendency will be to put American agriculture on a basis of home food production rather than intensive export production.—(*Nature*, Vol. CXL, No. 3546, p. 687, 1937.)

* * *

Effect of Moulds upon Tanning Liquors.

Several trees growing in the Philippine Islands yield liquors suitable for tanning purposes. The betel nut, *Areca Catechu*, the black wattle, *Acacia decurrens*, kalumpit, *Terminalia edulis*, and Kamachile, *Pithecolobium dulce*, are four of the most important trees. Tanning liquors prepared from them are, however, subject to attack by common mould fungi, and Messrs. Luz Baens and F. M. Yenko have investigated their action (*Philippine J. Sci.*, 61, No. 4, 417-428, Dec. 1936). They found that the activities of the fungi, *Penicillium glaucum* and *Aspergillus niger* gradually reduced the tannin content of prepared solutions. A rise in the relative acidity of the liquid was usually accompanied by a large decrease in tannin content. Variations in susceptibility of the liquids to attack by the fungi appeared, for extracts of betel-nut kernel and black wattle bark were susceptible to *A. niger*, but somewhat resistant to *P. glaucum*, whilst kalumpit bark extract allowed *P. glaucum* to increase more than *A. niger*. Both moulds would find their way to the liquid when natural infection took place during practical tanning operations.—(*Nature*, Vol. CXL, No. 3546, p. 687, 1937.)

THE subscription to *Tropical Agriculture* is six shillings per annum, post free, Trinidad currency, to all countries within the British Empire or seven shillings and six pence, post free, Trinidad currency, to all other countries. Subscriptions can commence at any time during the year.

TREND OF THE MARKETS.

[The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.]

SUGAR.—Prices on the Home Markets have ranged as follows (c.i.f. per cwt.):—

	Foreign.	*Preferential.*
	s. d.	*s. d.*
30th September	6 6	10 3
7th October	6 6	10 3
14th October	6 6	10 3
21st October	6 6	10 3
28th October	6 3	10 0
4th November	6 1½	9 10½
11th November	6 2¼	9 11½
(*12th November*, 1936)	4 11¼	8 8¼

Despite continued disquiet in the international political situation and a general decline in the price of other commodities and in the value of securities, the market for raw sugar has remained fairly steady with movements confined to very narrow limits. Sugar absorption has proceeded at a satisfactory rate and the general position of the article, as determined by the quotas laid down by the International Sugar Agreement is regarded with satisfaction by most market observers.

* * *

RUBBER.—Quotations for Plantation Sheet have ranged as follows:—

	Pence per lb.
29th September	8 1-2
6th October	7 5-16
13th October	7 7-8
20th October	7 5-8
27th October	7 1-4
3rd November	7 5-16
10th November	7
(*9th November*, 1936)	9 1-16

The market has generally been weaker with prices registering further declines. This is due to the continued general uncertainties of the political outlook and to a severe fall in American securities on Wall Street, which has caused all round liquidation on other stock exchanges and in many of the commodity markets. A further source of weakness was the news of a small failure in the market. The weakness in rubber is not due to anything inherent to the article itself although plenty of rubber is coming forward to supply immediate requirements. On the other hand, manufacturers' stocks have been heavily depleted and if circumstances were normal it is believed that steps would be taken to replenish these. The American consumption for the first nine months of the year works out at 441,096 tons as against 425,176 tons for the same period last year.

* * *

COPRA.—Steady with West Indian f.m.s. at £15 17*s.* 6*d.* c.i.f. London.

COCOA.—Various explanations have been advanced in an endeavour to justify the severe fall in cocoa prices which would appear to be due to a combination of circumstances. With the price of cocoa now more than 50 per cent. below the high of this year it is unlikely that shippers will show any real desire to sell. Anxiety on the part of manufacturers and dealers, especially those who usually overstay the market, may soon bring an improvement in demand. This should consequently result in an overdue correction in prices. Accra is now quoted at 27*s.* and locally $7.50 per fanega for Plantation Cocoa is paid.—(*By Courtesy of the Cocoa Planters' Association of Trinidad, Ltd.*)

* * *

COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association.

	American Mid.	*Egyptian. F.G.F. Sakel.*
24th September	5.08	7.68
1st October	4.89	7.37
8th October	4.75	7.81
15th October	4.82	7.46
22nd October	4.89	7.52
29th October	4.75	—
5th November	4.55	—
12th November	4.63	
(*13th November*, 1936)	6.71	11.72

There has been an easier tendency in raw cotton prices following upon a bearish report which estimated an increase in yield from 16,098,000 bales to 17,573,000 bales in the American cotton crop. Traders have also been confused by the political outlook. West Indian Sea Island has sold at 18*d.* to 24*d.* per lb.

* * *

LIME PRODUCTS.—*Lime Oil.* Handpressed is valued nominally at 35*s.* per lb. but there is no demand. Distilled is slow with sellers asking 25*s.* *Lime Juice.*—There is still no inquiry for Concentrated, and Raw shows practically no change at 1*s.* 9*d.* to 2*s.* 3*d.*—(*West India Committee Circular*, 21st October.)

* * *

BANANAS.—A fairly good trade demand with prices for Jamaicas unchanged at £19 5*s.* delivered London, and £19 nearest station Provinces. Brazilians are £1 lower at £13 delivered London and £14 delivered Provinces.